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## SEA-SIDE STUDY ON THE COAST OF CALIFORNIA.

BY J. WALTER FEWKES.

WITH the increased facilities for travel, the number of Eastern naturalists who visit California to collect marine animals with dredge and dip-net, will also increase. Those who are interested in the marine zoölogy of the Pacific Ocean will seek advice of those who have already studied there, as to the best place to carry on their work with profit and with least loss of time. To such the experiences of the author and his convictions as to a good place to prosecute this kind of work on the California coast may not be without interest.

A second and most important object in writing this paper is a plea for the establishment on the Pacific coast of a marine laboratory, where biological research of all kinds shall be carried on.

It is a great pleasure to a marine zoölogist to pull the dredge or drag the Müller's net<sup>1</sup> in waters where these implements have never been used. It is a source of real satisfaction to study a marine fauna in which a majority of the animals captured are new to science, and one may be pardoned if he speaks with enthusiasm of the results of such study.

Such places are many, and opportunities of this kind not so rare that naturalists are obliged to enter upon long journeys to reach them. Even upon the coast of New England where marine zoölogy has been cultivated for many years, the work can hardly be said to have more than begun, while great groups of marine animals have hardly been identified. A preliminary study, however, has been made, and, thanks to the researches of our naturalists whose names, known to all zoölogists, it is not necessary to mention, the facies of our New England marine fauna is known.

When, however, we turn to the western shores of North America, to the coast of California, Oregon and Washington Territory, we find a shore where this study is yet in the first stages of growth, for

<sup>1</sup> The net used in surface fishing. So called because so successfully used by the great naturalist, Johannes Müller.

here the dredge has been but little used, and the revelations of the Müller's net are almost unknown.

The marine animals of the Atlantic have been for a long time the continuous study of marine zoölogists. Those of the bays and seas of Europe and of the Eastern waters of the United States have been so sedulously investigated that it may be said that almost our whole knowledge of animals which live upon the surface of the ocean, is derived from this source. The Pacific Ocean, from its remoteness from centers of zoölogical activity or other causes, is almost wholly unexplored, and while good beginnings have already been made, even the facies of the surface fauna of the Eastern Pacific is practically unknown.

The coast of California, throughout its great length, offers extraordinary advantages for a study of this department of marine zoölogy, and yet, with one or two exceptions, the use of the Müller's net, early introduced on the Atlantic waters of the United States by the elder Agassiz, and so successfully used for so many years by several naturalists, is unknown on a coast washed by the largest ocean on the globe. The use of dredge and net has a great future in the study of the marine fauna of California.

In the first phase of the study of the surface life of the ocean, the work was almost wholly the result of individual enterprise, unaided by government or university appropriations. Naturalists visited, during their vacations, the North Sea, Nice, Villa Franca, Naples, or Messina, accompanied by students, and in that way the foundations of this knowledge were laid. The work which they did has been the admiration of naturalists and their verdict forms a part of the history of science. But in this pioneer work the older naturalists had difficulties to contend with which one who visits the well-appointed stations which have arisen in later years on the Mediterranean, knows nothing of. The places which offer the best localities for collecting were not known, practical fishermen had to be shown the animals which were wanted and how to collect them. In most cases the naturalist himself had to spend many hours on the water collecting, and precious time was used for what might have been done by others. The naturalist was investigator and collector, and his laboratory, oftentimes the room in which he lived, or some place poorly lighted and little fitted for his work. While the combination of collector and investigator in one and the same person <sup>1</sup>

<sup>1</sup> I know of no more absurd position than that of the closet naturalist who despises the collector, or of the anatomist or histologist who belittles

is sometimes an advantage, it is true that much work can oftentimes really be accomplished if these two functions are performed by specialists. In no short time there arose in Europe, in the best localities on the coast, permanent laboratories with all appliances for continuous work. It was no longer necessary for the investigator to explore the coast to find out where the best collecting grounds are, or to make arrangements with fishermen and educate them for the work.

He was no longer obliged to spend months in search of some animal whose favorite habitat and breeding place must be discovered before research upon their anatomy, embryology, or histology, could be carried on, but all these difficulties were reduced to a minimum. Well-endowed stations with equipments have arisen. Continuous observations in the same place have taught when and how certain animals can best be found; and the naturalist now economized time and money, while by working in the established laboratories he finds himself associated with others interested in the same work. Much praise must be given to the pioneers in this study, and the younger school of naturalists, from the vantage ground which they occupy, are apt to overlook the difficulties which those before them encountered.

On the Atlantic coast of the United States we have passed or are passing into a second stage in the development of the study of marine zoölogy. While the older American zoölogists in their earlier days sought the shore with no help from state or college, we now have well-equipped laboratories bringing many other advantages. The contributions to science made by the U. S. Fish Commission, Mr. Agassiz' Newport Marine Laboratory, and the Chesapeake Marine Laboratory, tell of the harvest which may come from the second stage in the development of marine research in America. While these stations have accomplished a great deal in carrying on the study, much is done every year by summer schools of natural history and by individual naturalists unconnected with any of these stations or schools. Professors of our colleges visit the shore with pupils, and in several instances have made extended investigations wholly independent of public or private marine laboratories. These efforts have much to recommend them, but are the systematic zoölogist. It is, as suggested to me by a well-educated naturalist for whom I have great respect, like the hands of the clock saying to the pendulum, "I have no need of thee."

often hampered for resources, as they involve in many instances large outlays for boats, dredges, and fishermen. Moreover, some of the best localities for the study of marine zoölogy are visited by these private parties.

On the Pacific coast the study of marine zoölogy has entered upon the first phase of the development, but has not passed to the second. No marine station has yet been founded there. The naturalist who seeks those shores must himself discover the best place to work. He finds no fisherman familiar with his needs, and must educate them in the use of the dredge. In short, feels that he is veritably a pioneer, if he has in mind the use of the net and dredge. The delights and results of his work, however, are those which come to the first worker in a new field.

When I had decided to visit the California coast to study its marine fauna, the first information which I sought was where is the best place to get the best results in the shortest time? The first question which was asked local naturalists was, where is the best place for the study of marine zoölogy on the coast? I received in most cases no satisfactory answers, and perhaps I ought not to have expected them. Prominent marine zoölogists in Europe differ in their estimates of the value of localities on the Mediterranean as collecting places. Many say Villa Franca, others Naples, others Messina. On the coast of New England some of our prominent naturalists prefer Newport, others Wood's Holl, others Eastport. Every one has a preference, but it is a known fact that there are some places on our coast which no one recommends. The coast of California, however, has been so little studied that even the satisfaction of knowing the prominent places was not allowed, as I could find almost no one who had used the dredge. The first thing necessary there was a kind of geographical exploration to discover a good place for work.

It may be of advantage to others who have in mind a visit to the Pacific coast for work similar to that which I carried on to know the result of my experiences. I have used the dredge and Müller's net at Santa Barbara, and among the neighboring islands, at Port Harford, Santa Cruz and Monterey. I can recommend any of these places for this kind of work; but I prefer the Bay of Monterey, and think if ever a marine station is founded on the coast of California, no better site can be chosen north of Point Conception than on this beautiful bay. I am sanguine enough to hope that in

time two marine stations will arise on this coast, in which case the Bay of Monterey and either San Diego<sup>1</sup> or Santa Barbara might well be chosen.

There are several desiderata which influences the marine zoölogist in his choice of a working place upon any shore. The first, perhaps the most important one, is whether the collecting is good, whether there are many animals at the place recommended. This is an all important, but it is by no means the only question. Of what use is it to a naturalist if he can stand on a wharf and see a wealth of surface life float by and can get no boat to collect it? This might seem an absurd condition on the coast of New England where every coast hamlet has so many boats; but I have been in a considerable village on the coast of California where one or two large, undesirable boats were the only boat facilities of the place. In Santa Barbara, which has the reputation of being a boating place, you can count on your two hands the number of small boats for rent. Several conditions have brought about this result. In most places the wharf is built out from a beach on which the surf is continually breaking. There is no protection for boats, and the fondness of the New England coast people for the water is not known. Although so many strangers come to Santa Barbara, there are few pleasure boats and no skippers. Compare this condition with the wharfs, for instance, at Newport or Eastport.

It is not alone necessary for the marine zoölogist that he should have a good collecting ground and a boat, but he must be able to reach the coast easily. If he studies animals alive his laboratory must be on the shore, for pure water must be continually supplied, and the live animals of the fragile nature of many marine creatures cannot be carried for long distances without harm. It is best if his laboratory is as near as possible to the water. The New England fishing towns, many of which arose as fishing hamlets, lie upon the very shore, and accommodations are easily found to satisfy the naturalist's wants. That is not always the case, however, in towns which have originated like those of California. The holy fathers who were the founders of Santa Barbara and Santa Cruz did not look to the sea for a livelihood. The first settlers were not fisher-

<sup>1</sup> Unfortunately, circumstances prevented my spending any time at San Diego in the study of surface animals or in dredging. I confess my ignorance of its advantages, which from what I could learn from others and my own superficial examination of the neighboring coast, must be very great.

men, nor was commerce at first of great importance. As a result many of the coast towns are separated by some distance from the wharf or landing-place. One knows how much discomfort this may mean to a naturalist if he has trudged along over a mile from the wharf to the nearest house he could rent for a laboratory, with a water-bucket filled with the products of surface fishing by night, and if twice a day he has been obliged to replenish the water by a similar tramp. Time is lost which might be employed for work, and the naturalist cannot watch and take advantage of the ever changing conditions of the sea and wind if his workshop is a mile or more from his boat. The naturalist who studies ichthyology,<sup>1</sup> and who visits the fish markets when the fishermen return from their nets, does not feel these discomforts which the naturalist who must collect for himself has.

A good collecting-place, boats, and ready access to the water are three requisites in a choice of a good station for marine work. They are the great difficulties which the pioneers in marine zoölogy have always encountered. The naturalist who works in a well-equipped station, with trained fishermen for collectors, knows little of these difficulties. Until, however, a zoölogical station is founded on the coast of California these three things, unfortunately or fortunately, must have great influence in his choice of a working-place.

The Eastern zoölogist, who has worked on the Atlantic, encounters several physical characteristics on the coast which are new to him. The absence of those nooks and indentations of the coast, pockets in which floating life is driven by the currents and winds, is a marked feature of the coast line. Many of the harbors are open roadsteads upon which a surf is continually breaking. While this feature is in some respects a disadvantage, it is in others an advantage.

Along the coast in many places, as at Santa Barbara, a zone of floating kelp undoubtedly prevents many floating animals from being washed to the shore. This kelp extends for miles along the coast, and it is only where the bottom sinks immediately to a great

<sup>1</sup> In this article I have considered more especially the needs of the student of the marine invertebrated animals, as the largest share of oceanic life belongs to these groups. In many instances it will be found that the needs of the ichthyologist are very different. They have little to do with dredging, but the student of the embryology of marine fishes and their younger stages will appreciate what is desired in work with the Müller's net.

depth near the shore that it is absent. While it may shut out effectually many floating things from the neighborhood of the wharf, it shelters in its fronds many others; while the root-like attachments to the rocks harbor many interesting animals. Between the zone of kelp and the shore was not found to be a profitable dredging-ground. The interval appears to be filled with decaying fragments of the kelp, and the dredge comes up filled with this debris. Dredging in the belt of the kelp itself is impossible.

The best dredging at Santa Barbara is in the channel about four miles outside the outer border of the kelp. The rocks in places entangle and catch the dredge, and the bottom is, except in one or two places, very rocky. Off Punta del Castillo, near Santa Barbara, there is some good ground for dredging, but it is hard to pull the dredge on account of the many submarine rocks. From Santa Barbara across the channel to the Santa Barbara Island, there are many rocks, but the dredging is good in places. The vicinity of Carpinteria is the best place of all about Santa Barbara for dredging.

The island of Santa Cruz,<sup>1</sup> one of the most beautiful islands of the Santa Barbara group, offers fine surface collecting. The dredging is difficult on account of the many submarine rocks and the depth of the water. To one visiting the island for zoölogical study no better anchorage can be found than a small cañon resorted to by otter hunters near Punta Diablo. The shore collecting on the beach at Santa Barbara is poor. At Punta del Castillo many interesting animals were found.

Santa Barbara on the whole offers good facilities for the study of marine zoölogy. The fauna of the shore is not rich, but it is varied, and that of the neighboring islands is all that could be desired. The surface fauna of the Santa Barbara channel is very rich and dredging in it is excellent. I do not believe the shore at Santa Barbara can compare with that to the south by Del Mar and San Diego as a collecting place for the naturalist, but the dredging is good and the surface collecting all that could be wished.

<sup>1</sup> Especial interest is attached to a study of this island from the curious distribution and character of the flora as compared with that of the main land. This island, continental to all outward appearances, has a more peculiar flora than the Bermudas, although they are only a little over twenty miles from the shore, while the Bermudas are five hundred. No more interesting problems can be studied in regard to the geographical distribution of animals than the character of the life of the islands near Santa Barbara.



In order to study the conformation of the coast of California between Santa Barbara and the Bay of Monterey, and to form a judgment of the advantages of the several ports for natural history work, I took one of the smaller steamers of the Pacific Navigation Company, which touches at the several landings. I did not dredge in all these places and my judgments may be more or less hastily made. They are thought to be of some worth.

Gaviota seems illy adapted for surface work, as I am told that a stiff breeze from the mountain pass almost continually ruffles the sea. As we approached the wharf at about nightfall a cold boisterous wind from the mountains seemed to prevent any night work with the net.

Port Harford seemed made on purpose for the study of marine zoölogy. The wharf is well situated for landing with treasures, and the hotel is contiguous to the shore. Small islands and rocks of ready access afford good collecting ground for litoral animals. Many floating animals were observed in the neighborhood of the landing.

San Simeon and Cayucos are open roadsteads with few fishermen, and seem little calculated for the purposes of the naturalist.

The little hamlet of El Moro lies favorably for work, but at present the steamers do not land there. These three places would be interesting places to carry on marine research, as few animals have been recorded from their neighborhood, and they are rarely visited by naturalists.

The coastline from Cayucos to Monterey is one series of lofty cliffs which have been little explored. No villages large enough to necessitate the landing of the steamers exist, and although there is probably a multitudinous marine life in the water, no point seems adapted at present for the study without great inconveniences. It would be impossible to get boats and fishermen on this unknown coast. San Simeon is a dairy town and few fishermen are found there, although there is an easy communication with San Francisco and other prominent ports on the Pacific, by means of the Pacific Steamship Company.

Santa Cruz presents many conditions which render it a good place for the marine zoölogist to work. There are many fishermen and boats can be had at reasonable rates. It has good hotels and boarding-houses contiguous to the landing-places. There is a good sandy beach and near by rocky cliffs both with characteristic life. The

dredging is good. The neighboring town, Soquel, when there are many fishermen, presents many facilities for the naturalist.

Collecting on the piles of the wharf is not as good as at Santa Barbara. There is no belt of kelp forming a thick zone shutting out the floating genera from the shore. The phosphorescence is at times superb, but surface collecting in the afternoon was found to be next to impossible. The beach is more sheltered than that of Santa Barbara, but it rarely happens that the surf does not break on the shore. Sheltered caves or natural pockets in which floating life are caught are rare.

Taken all in all, Monterey <sup>1</sup> is one of the best places on the coast of California for a naturalist to station himself for a study of the marine life of the Pacific. It may not be the best, but experience has taught me that it is *one* of the best, and a visit there by a naturalist will be amply repaid by novelties if his object be research.

The surface fauna is rich and there is good dredging. There are boats of all sizes and many fishermen. The city lies near the shore and one is not forced to waste time in reaching the wharf from the hotel. The means of communication with the outside world are easy. I find, on reference to my note book, that many of my choicest specimens came from this locality.

Stimpson found the bay of San Francisco nearly barren of a varied marine life except at its entrance. This condition he ascribed to the admixture with its water of the turbid flood of two large rivers and the small size of the gate which admits the clear waters of the ocean. A short and somewhat superficial examination of the resources of the bay lead me to a somewhat similar conclusion, yet I find the entrance to the bay one of the best places for floating animal life. From the wharf several very interesting floating animals were taken, and there is evidence that the marine zoölogist will find plenty to occupy his attention within a short distance from the city. A great advantage of San Francisco as the site for zoölogical work is the vicinity to scientific libraries and the number of fishermen and fishing boats which the city has.

Climatic conditions on the coast of California render certain times of the year most advantageous for work with dredge and net. In most parts the morning is the best time for surface collecting. A

<sup>1</sup> Camelo Bay is believed to be one of the most advantageous places for the study of marine zoölogy between Point Conception and San Francisco.

stiff breeze ordinarily arises in the afternoon and renders the collection of surface life almost impossible. Surface collecting by night, so profitably carried on at Newport, met with considerable success on the coast of California. The fogs which in some months hang for many hours above the water is detrimental to this kind of work.

Calms, while of great advantage to the student of surface collections, try the patience of the naturalist engaged in dredging who has no steam launch at his control. The best time to dredge <sup>1</sup> with a sailing craft was found to be about noontime, as there is less liability to be becalmed at that time, and it is too early for the heavy winds of the afternoon.

In my trip across the Santa Barbara Channel, the Müller's net was used at intervals to get some idea of the general facies of the surface life from this region of the Pacific. The contents of the net was made up of representatives of all the more important surface animals from the Narragansett Bay. These animals are of course represented by different genera and species from those found in New England waters, but the general character of the surface life is much the same. As compared with the same latitudes on the Atlantic, it did not seem as rich.<sup>2</sup>

The phosphorescence which is a direct index of the amount of surface life in the sea is often very brilliant on the Pacific coast. I have studied this light at various points on the Mediterranean, along the Florida Keys, on the coast of New England and at the Bermudas but have never seen it more striking than in the surface waters of the Santa Barbara Channel and in the fiords of the island of Santa Cruz. In a canon fiord under Punta del Diablo, at about 9 o'clock in the evening, I witnessed a phosphorescent display of this kind of most extraordinary character. Aside from its natural beauty it was indicative of an abundant harvest with the Müller's net. The signs did not fail, although the light, as so often happens in surface collecting, was mainly due to multitudes of one genus of animals. At this time it was due to large numbers of a species of Copepod which is often very abundant in the Santa Barbara Channel.

I have noticed in studies of live animals carried on at the Bermudas, at Tortugas and on the coast of New England, that in the

<sup>1</sup> I refer to shallow-water dredging and to dredging with the sailing crafts which a visitor to the coast is obliged to use.

<sup>2</sup> The author has in preparation a paper in which the new genera and species of invertebrated animals found on the coast of California in surface collecting and shallow-water dredging will be described and figured.

former localities marine animals in aquaria are very tenacious of life. I believe this is in part due to the fact that there is a more uniform temperature in the winter at Tortugas, or that the changes are not as sudden in one place as in the other. At Newport, for instance, the temperature of the water varies very greatly day by day, and pelagic animals are very sensitive to this change. Pelagic animals at Santa Barbara live longer without change of water than those on the coast of New England, and the conditions of temperature seem more like those of Bermuda than of the coast of New England.

I was much surprised at the great range of temperature which the common Actinian of California can bear without harm. Water which is almost lukewarm does not kill it. In pools left by the tide well-expanded specimens live for hours in water exposed to the rays of the sun. By the peculiar habit which they have of covering themselves with sand they are able to live out of the water in the warm air for several hours.

I can think of few more difficult tasks than to determine the best locality in New England to place a zoölogical station. Any committee which has such a task, especially if a majority of its members are those who have never done any marine zoölogical work at any place, has my hearty sympathy. There may be places better adapted for this or that kind of work, better suited for the size of the endowment or more convenient of access, but it is a hard task to declare which is the best place for a station. One is tempted to say that there is no place which is bad if the naturalist means to *do* work rather than discourse on *how* to do it.

On the Pacific coast the problem is the same as on the Atlantic. One cannot say that this or that point is the best place to work until he or others have tried all. Honest work at almost any place on the Pacific as on the Atlantic marine zoölogy will bear good fruit.

The time has come when a permanent, well-endowed zoölogical station is needed for the study of marine animals of the coast of California. An abundant harvest in all branches of zoölogical study awaits those whose good fortune it may be to originate and carry on such a station.

While it is not intended in this article to belittle the contribution to our knowledge of the animals of the coast which have already been made, it is believed that the work already begun is but a small part of what will result if a permanent station, directed by those

who have been drilled in methods of study in marine laboratories in Europe and America, is established.<sup>1</sup>

The author has been told that a movement is now on foot to found a marine zoölogical station in California. It is hoped that the information is correct. It is believed that if such a laboratory is properly conducted it will lead to most important results in the advancement of science.

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## EDITORS' TABLE.

EDITORS: E. D. COPE AND J. S. KINGSLEY.

THE satire which has been everywhere for a half century leveled at the classical names of towns in New York State, given by some schoolmaster who was in a position to give them, should have taught American nomenclators of later date a lesson. Perhaps the reference to the classical dictionary has been less frequent since that time, but the poverty of imagination of the modern American has been none the less apparent. It is pardonable in immigrants to name a locality in America after their birthplace in some European country; but when the "stock American" must search European and classical geographies for names, he advertises two things: first, his want of esthetic capacity; second, if perchance he select some euphonious name from the Greek, his want of national spirit and character—in form at least. What can be more incongruous than the naming of one of the canyons of Colorado the Canyon of Lodore! But what especially moves us to make these remarks is the fact that we are threatened, according to the daily press, with a still more objectionable piece of Jenkinsism. The plain adjacent to the Salt River of Arizona, where so many important archæological

<sup>1</sup> It would be a most interesting part of my article, if space permitted, to record the many valuable papers which have already been published on Californian Marine Invertebrated Animals. These are mostly in systematic zoölogy. The Molluca are well known, something is known of the Crustacea, Echinoderms, Actinians, and Medusæ. The sponges, Bryozoa, Tunicata, Worms, Nudibranchs and one or two other groups await even systematic identification and description. The study of larval forms of animals, of embryology, of anatomy and histology is almost unknown as far as California marine invertebrates are concerned.